

is a woman at all, is sure to be a lover of some existing individual. Thirdly, 'Some favoured patriarch is translated' means that a certain description applies to a select individual. A hypothetical proposition, whether it be conditional (of which the alternative, or disjunctive, proposition is a mere species, or *vice versa*, as we choose to take it) or copulative, is either general or *ut nunc*. A general conditional is precisely equivalent to a universal categorical. 'If you really want to be good, you can be,' means 'Whatever determinate state of things may be admissibly supposed in which you want to be good is a state of things in which you can be good.' The universe is that of determinate states of things that are admissible hypothetically. It is true that some logicians appear to dispute this; but it is manifestly indisputable. Those logicians belong to two classes: those who think that logic ought to take account of the difference between one kind of universe and another (in which case, several other *substantiae* of propositions must be admitted); and those who hold that logic should distinguish between propositions which are necessarily true or false together, but which regard the fact from different aspects. The exact logician holds it to be, in itself, a defect in a logical system of expression, to afford different ways of expressing the same state of facts; although this defect may be less important than a definite advantage gained by it. The copulative proposition is in a similar way equivalent to a particular categorical. Thus, to say 'The man might not be able voluntarily to act otherwise than physical causes make him act, whether he try or not,' is the same as to say that there is a state of things hypothetically admissible in which a man tries to act one way and voluntarily acts another way in consequence of physical causes. As to hypotheticals *ut nunc*, they refer to no range of possibility, but simply to what is true, vaguely taken collectively.

Although it is thus plain that the action of the copula in relating the subject-term to the predicate-term is a secondary one, it is nevertheless necessary to distinguish between copulas which establish different relations between these terms. Whatever the relation is, it must remain the same in all propositional forms, because its nature is not expressed in the proposition, but is a matter of established convention. With that proviso, the copula may imply any relation whatsoever.

So understood, it is the *abstract copula* of De Morgan (*Camb. Philos. Trans.*, x. 339). A *transitive copula* is one for which the mood Barbara is valid. Schröder has demonstrated the remarkable theorem that if we use *r* in small capitals to represent any one such copula, of which 'greater than' is an example, then there is some relative term *r*, such that the proposition '*S is r to P*' is precisely equivalent to '*S is r to P* and *r* to whatever *P is r to*.' A *copula of correlative inclusion* is one for which both Barbara and the formula of identity hold good. Representing any one such copula by *is* in italics, there is a relative term *r*, such that the proposition '*S is P*' is precisely equivalent to '*S is r to P* and *r* to whatever *P is r to*.' If the last proposition follows from the last but one, no matter what relative *r* may be, the copula is called the *copula of inclusion*, used by C. S. Peirce, Schröder, and others. De Morgan uses a copula defined as standing for any relation both transitive and convertible. The latter character consists in this, that whatever terms *I* and *J* may be, if we represent this copula by *is* in black=letter, then from '*I is J*' it follows that '*J is I*.' From these two propositions, we conclude, by Barbara, that '*I is I*.' Such copulas are, for example, 'equal to,' and 'of the same colour as.' For any such copula there will be some relative term *r*, such that the proposition '*S is P*' will be precisely equivalent to '*S is r to everything*, and only to everything, to which *P is r*.' Such a copula may be called a *copula of correlative identity*. If the last proposition follows from the last but one, no matter what relative *r* may be, the copula is the *copula of identity* used by Thomson, Hamilton, Baynes, Jevons, and many others.

It has been demonstrated by Peirce that the copula of inclusion is logically simpler than that of identity.

Diagram: see LOGICAL DIAGRAM.

Diallogism. A form of reasoning in which from a single premise a disjunctive, or alternative, proposition is concluded introducing an additional term; opposed to a syllogism, in which from a copulative proposition a proposition is inferred from which a term is eliminated.

Syllogism.

All men are animals, and all animals are mortal;

∴ All men are mortal.

Diallogism.

Some men are not mortal;

∴ Either some men are not animals, or some animals are not mortal.

Dimension. An element or respect of extension of a logical universe of such a nature that the same term which is individual in one such element of extension is not so in another. Thus, we may consider different persons as individual in one respect, while they may be divisible in respect to time, and in respect to different admissible hypothetical states of things, &c. This is to be widely distinguished from different universes, as, for example, of things and of characters, where any given individual belonging to one cannot belong to another. The conception of a multidimensional logical universe is one of the second conceptions which exact logic owes to O. H. Mitchell. Schröder, in his then second volume, where he is far below himself in many respects, pronounces this conception 'untenable.' But a doctrine which has, as a matter of fact, been held by Mitchell, Peirce, and others, on apparently cogent grounds, without meeting any attempt at refutation in about twenty years, may be regarded as being, for the present, at any rate, tenable enough to be held.

Dyadic relation. A fact relating to two individuals. Thus, the fact that *A* is similar to *B*, and the fact that *A* is a lover of *B*, and the fact that *A* and *B* are both men, are dyadic relations; while the fact that *A* gives *B* to *C* is a triadic relation. Every relation of one order of relativity may be regarded as a relative of another order of relativity if desired. Thus, *man* may be regarded as *man coexistent with*, and so as a relative expressing a dyadic relation, although for most purposes it will be regarded as a monad or non-relative term.

Index (in exact logic): see sub verbo.

Many other technical terms are to be found in the literature of exact logic.

Literature: for the study of exact logic in its more recent development, excluding probability, the one quite indispensable book is SCHRÖDER, *Algebra d. Logik*; and the bibliography therein contained is so exhaustive that it is unnecessary to mention here any publications previous to 1890. Schröder's pains to give credit in full measure, pressed down and running over, to every other student is hardly less remarkable than the system, completeness, and mathematical power of his work, which has been reviewed by C. S. PEIRCE in the *Monist*, vii. 19-40, 171-217. See also C. S. PEIRCE, *Studies*

in *Logic*; *Pop. Sci. Mo.*, xii. 1; and *Proc. Amer. Acad. Arts and Sci.*, vii. 287. Cf. SCIENTIFIC METHOD. (C.S.P.)

Logic (of chance): see PROBABILITY.

Logic (of emotion): see TERMINOLOGY, English, 'Affective Logic.'

Logic (social): see SOCIAL LOGIC.

Logic (symbolic): see SYMBOLIC LOGIC.

Logical [Lat. *logicalis*, from *logica*, logic]: Ger. *logisch*; Fr. *logique*; Ital. *logico*. Irrespective of any facts except those of which logic needs to take cognizance, such as the facts of doubt, truth, falsity, &c.

Logical possibility is, according to usage, freedom from all contradiction, explicit or implicit; and any attempt to reform the inaccuracy would only bring confusion.

Logical necessity is the necessity of that whose contrary is not logically possible.

Logical induction is an induction based on examination of every individual of the class to which the examination relates. Thus, conclusions from a census are logical inductions. While this mode of inference is a degenerate form of induction, it also comes into the class of dilemmatic reasoning.

Logical truth is a phrase used in three senses, rendering it almost useless.

1. The harmony of a thought with itself. Most usually so defined, but seldom so employed. So far as this definition is distinct, it makes logical truth a synonym for logical possibility; but, no doubt, more is intended (Hamilton, *Lects. on Logic*, xxvii).

2. The conformity of a thought to the laws of logic; in particular, in a concept, consistency; in an inference, validity; in a proposition, agreement with assumptions. This would better be called *mathematical truth*, since mathematics is the only science which aims at nothing more (Kant, *Krit. d. reinen Vernunft*, 1st ed., 294).

3. More properly, the conformity of a proposition with the reality, so far as the proposition asserts anything about the reality. Opposed, on the one hand, to metaphysical truth, which is an affection of the *ens*, and on the other hand to ethical truth, which is telling what a witness believes to be true (Burgersdicius, *Inst. Met.*, chap. xviii).

Logical parts and whole. Parts and whole of logical extension.

Logical reasoning. Reasoning in accordance with a LEADING PRINCIPLE (q.v.) which thorough analysis, discussion, and experience have shown must lead to the truth, in so far as it is relied upon. But what Aristotle

LOGICAL DIAGRAM — LOGICAL MACHINE

understood by a logical demonstration may be seen in his *De generatione animalium*, Lib. II. cap. viii.

Logical presumption. A Wolfian term for synthetic reasoning, that is, induction and analogy; for hypothetic reasoning was not recognized as reasoning at all. The uniformity of nature is called the *principle of logical presumption*.

Logical division. Division into logical parts.

Logical distinctness. That distinctness which results from logical analysis.

Logical actuality. Kant, in the *Logik* by Jäsche (Einleitung, vii), defines logical actuality as conformity to the principle of sufficient reason, consisting of the cognition having reasons and having no false consequences; and he makes this, along with logical possibility, to constitute logical truth, which is thus used in its second sense. But in the *Critic of the Pure Reason*, in discussing the functions of judgments (1st ed., 75), he says that an assertoric proposition asserts logical actuality (*Wirklichkeit*, which Max Müller wrongly translates 'reality'), and makes this phrase synonymous with logical truth (which is thus used in its third, and proper, sense).

Logical definition. A strict definition by genus and specific difference. Ockham and his followers objected to the designation on the ground that the logician, as such, had no occasion to define any ordinary term, such as man (*Tractatus logices*, Pt. I. chap. xxvi). (C.S.P.)

Logical Diagram (or Graph): Ger. *logische Figur*; Fr. *diagramme logique*; Ital. *diagramma logico*. A diagram composed of dots, lines, &c., in which logical relations are signified by such spatial relations that the necessary consequences of these logical relations are at the same time signified, or can, at least, be made evident by transforming the diagram in certain ways which conventional 'rules' permit.

In order to form a system of graphs which shall represent ordinary syllogisms, it is only necessary to find spatial relations analogous to the relations expressed by the copula of inclusion and its negative and to the relation of negation. Now all the formal properties of the copula of inclusion are involved in the principle of identity and the *dictum de omni*. That is, if r is the relation of the subject of a universal affirmative to its predicate, then, whatever terms X , Y , Z may be,

Every X is r to an X ; and

if every X is r to a Y , and every Y is r to a Z , every X is r to a Z . Now, it is easily proved by the logic of relatives, that to say that a relation r is subject to these two rules, implies neither more nor less than to say that there is a relation l , such that, whatever individuals A and B may be,

If nothing is in the relation l to A without being also in the same relation l to B , then A is in the relation r to B ; and conversely, that,

If A is r to B , there is nothing that is l to A except what is l to B .

Consequently, in order to construct such a system of graphs, we must find some spatial relation by which it shall appear plain to the eye whether or not there is anything that is in that relation to one thing without being in that relation to the other. The popular Euler's diagrams fulfil one-half of this condition well by representing A as an oval inside the oval B . Then, l is the relation of being included within; and it is plain that nothing can be inside of A without being inside B . The relation of the copula is thus represented by the spatial relation of 'enclosing only what is enclosed by.' In order to represent the negation of the copula of inclusion (which, unlike that copula, asserts the existence of its subject), a dot may be drawn to represent some existing individual. In this case the subject and predicate ovals must be drawn to intersect each other, in order to avoid asserting too much. If an oval already exists cutting the space in which the dot is to be placed, the latter should be put on the line of that oval, to show that it is doubtful on which side it belongs; or, if an oval is to be drawn through the space where a dot is, it should be drawn through the dot; and it should further be remembered that, if two dots lie on the boundaries of one compartment, there is nothing to prevent their being identical. The relation of negation here appears as 'entirely outside of.' For a later practical improvement see Venn, *Symbolic Logic*, chap. xi. (C.S.P.)

Logical Machine: Ger. *logische Machina*; Fr. *machine logique*; Ital. *macchine logistiche* (E.M.). An instrument devised to facilitate by mechanical means the handling of logical symbols or diagrams.

There are three such instruments which merit attention:—

(1) The first was constructed by W. Stanley Jevons in 1869 (announced in his *Substitution of Similars*, 1869, 60; described in *Philos.*

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